UNITED STATES PATENT AND TRADEMARK OFFICE

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/766,599	01/27/2004	Howard S. Taylor	028080-0119	3408

7590 02/24/2006	EXAMINER	
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2049 Century Park East	ART UNIT	PAPER NUMBER
Los Angeles, CA 90067	2644	

DATE MAILED: 02/24/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

	Application No.	Applicant(s)
Office Action Summary	10/766,599	TAYLOR ET AL.
	Examiner	Art Unit	
	Daniel R. Sellers	2644	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE _3_ MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1) ☒ Responsive to communication(s) filed on <u>09 December 2005</u>.

2a) ☒ This action is **FINAL.**   2b) ☐ This action is non-final.

3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4) ☒ Claim(s) _1-24_ is/are pending in the application.

    4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5) ☐ Claim(s) _____ is/are allowed.

6) ☒ Claim(s) _1-24_ is/are rejected.

7) ☐ Claim(s) _____ is/are objected to.

8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9) ☐ The specification is objected to by the Examiner.

10) ☒ The drawing(s) filed on <u>27 January 2004</u> is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.

    Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

    Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

    a) ☐ All   b) ☐ Some * c) ☐ None of:

      1. ☐ Certified copies of the priority documents have been received.

      2. ☐ Certified copies of the priority documents have been received in Application No. _____.

      3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

    * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)

2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)

3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
    Paper No(s)/Mail Date _____.

4) ☐ Interview Summary (PTO-413)
    Paper No(s)/Mail Date. _____.

5) ☐ Notice of Informal Patent Application (PTO-152)

6) ☐ Other: _____.

DETAILED ACTION

Claim Rejections - 35 USC § 103

1.   The text of those sections of Title 35, U.S. Code not included in this action can

be found in a prior Office action.

2.   Claims 1, 2, and 4-8 are rejected under 35 U.S.C. 103(a) as being unpatentable

over the IEEE Nuclear Science Symposium and Medical Imaging Conference paper

titled "Application of DSP Techniques to Nuclear Magnetic Resonance Spectroscopy"

by Worley et al. and Keller et al., U.S. Pat. No. 5,041,789 (hereinafter Worley and Keller

respectively).

3.   Regarding claim 1, Worley teaches   .

An apparatus for performing spectral analysis, the apparatus comprising:
a. a data acquisition system configured to measure a signal emitted from a sample in response to
excitation energy applied thereto (col. 1, first paragraph), *and to average the measured signal over a*
plurality of measurements to generate an averaged signal (col. 3, first paragraph),

b. a data processing system including:
a noise-reduction pre-processor configured to create a vector space from said averaged signal, and to
generate the singular values and corresponding eigenvectors of a correlation matrix constructed within
said vector space, said vector space containing a noisefree signal subspace and a noise subspace, said
singular values including noisefree singular values associated with said noisefree signal subspace, and
noise singular values associated with said noise subspace (col. 3, second paragraph); *and*

c. a control system configured to identify a gap between a noisefree singular value and an adjacent noise
singular value, so as to request the data acquisition system to perform additional measurements if no
such separation can be identified, and to prevent further measurements from being made by the data
acquisition system if the appearance and stability of said gap can be established.

Worley teaches a data acquisition system that averages the measurements over a

plurality of samples and teaches a data processing system that performs

eigendecomposition on the measurements. Eigendecomposition (or Singular Value

Decomposition) involves transforming the input data into eigenvalues and their

corresponding eigenvectors. A matrix of M by N dimensions can be viewed as a set of

M vectors of N length or N vectors of M length (i.e. a 3x3 matrix has 3 dimensions or is a vector space with 3 dimensions). Worley teaches that the eigendecomposition creates an eigenspace with a noise and a noisefree subspace. It is well known that singular values are eigenvalues. Worley does not teach the control system. Keller teaches a control system in an NMR system that prevents further measurements from being made when a gap is identified, or a minimum signal-to-noise ratio (SNR), is reached (Col. 9, lines 11-37). It would have been obvious for one of ordinary skill in the art to combine the teachings of Worley and Keller for the purpose of creating a more user-friendly device. It is obvious that a minimum SNR criteria includes finding a stable gap between the noise and the noisefree singular values, wherein the SNR defines the magnitude difference between those singular values.

4.   Regarding claim 2, with respect to claim 1, the further limitation,

... said spectral analysis comprises an NMR spectral analysis, said excitation energy comprises RF excitation pulses, and said measured signal comprises an NMR transient.

See claim 1, Worley teaches a system that performs singular value decomposition in NMR spectral analysis.

5.   Regarding claim 4, with respect to claim 1, the further limitation, see Worley,

... said noise-reduction preprocessor comprises:

a. a matrix generator configured to form a vector space from the averaged signal (col. 3, first paragraph) *and constructing a correlation matrix within the vector space, the vector space containing a noisefree signal subspace and a noise subspace;* (col. 3, second paragraph).

b. a matrix diagonalizer configured to diagonalize the correlation matrix to obtain its singular values and the corresponding eigenvectors, the singular values including noisefree singular values associated with the noisefree signal subspace, and noise singular values associated with the noise subspace, and

c. a signal projector configured to project the averaged signal onto the noisefree subspace to generate a noise-reduced signal. (Col. 3, end of second paragraph).

With regard to the preceding limitation that the correlation matrix is diagonalized, it is a

well-known step in the art of singular value decomposition or eigendecomposition, and

as such is inherent. Worley teaches, at the end of the second paragraph in the third

column, that "eigenvectors are then used to construct a spectrum estimate.", wherein it

is inherent that the signal is reconstructed by projecting the signal onto the signal

subspace and ignoring the space comprised of the noise vectors.

6.   Regarding claim 5, with respect to claim 4, the further limitation, see the

preceding argument with respect to claim 4. Worley and Keller teach the features of the

preceding claim and Worley teaches that a spectrum is created using the eigenvectors.

It is inherent that a frequency domain transform is used to create the spectrum.

7.   Regarding claim 6, with respect to claim 1, the further limitation, see Worley

*... said data acquisition system is configured to sample each measured signal with a sampling period $\therefore$,
and to average the corresponding sample points over said plurality of measurements* (col. 3, first
paragraph), *so as to store said averaged signal as a discretized set of N data points c_n (n = 0, . . . , N-1).*

Worley does not teach a system with a sampling period or a step of discretizing the

input. Since Worley uses DSP techniques, sampling with an appropriate frequency (at

least twice the highest signal frequency) and digitizing the samples would have been

inherent in order to perform DSP.

8.   Regarding claim 7, with respect to claim 6, the further limitation

*... said data processing system is configured to store each data point c_n as a noisefree component x_n (n =
0, . . . , N-1) and a noise component M_n (n = 0, . . . , N-1), and to store each noisefree component x_n as a
finite sum of damped complex harmonics weighted by respective coefficients.*

Worley teaches a system that separates the signal into two subspaces by means of

singular value decomposition (col. 3, second paragraph). It is inherent that the signal

when separated into its components would have been stored as the noisefree

component and the noise component. Worley does not teach a system that stores

damped complex harmonics, however Worley teaches that prior art used the discrete

Fourier transform, which converts the signal to finite sums of damped complex

harmonics weighted by coefficients, to create spectral information from NMR transients.

It would have been obvious to one of ordinary skill in the art to use these teachings to

create a device that stores the noisefree components as a finite sum of damped

complex harmonics weighted by coefficients, in order to save computational time by

converting to the frequency domain only once.

9.   Regarding claim 8, with respect to claim 7, the further limitation,

*... said sum is over a number K of said damped complex harmonics, so that each noisefree component x_n
can be stored as:*

$x_n = ; d_k \exp (-iw_k .: n)$

*where d_k represents the weighting coefficient of the k-th damped complex harmonics, and w_k represents
the complex frequency of the k-th damped complex harmonics.*

See the rejection of claim 7, prior art teaches the use of Fourier techniques in spectral

analysis. It would have been obvious to require the storage of coefficients

corresponding to complex frequencies, as this is a well known method in the art.

10.   Claims 9-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over

Worley and Keller as applied to claims 1, 2, and 4-8 above, and further in view of

Trickett, U.S. Patent Application Publication 2004/0054479.

11.   Regarding claims 9 and 10, with respect to claims 1 and 9 respectively, the

further limitation of claim 9, see Trickett,

... said data acquisition system further comprises a windowing subsystem configured to apply a windowing filter to a Fourier transform of said averaged signal, so as to generate one or more decimated signals having a limited bandwidth. (fig. 5, unit 530)

and the further limitation of claim 10, see Trickett

... said data processing system is configured to store the inverse Fourier transform (fig. 5, unit 570) *of each decimated signal as a set of N_d decimated data points c_n^d (n = 0,..., N_d-1), and wherein said set of decimated data points have a signal length N_d that is substantially less than N and a sampling period T_d that is substantially greater than .:.*

The application of Trickett teaches a method of noise reduction using matrix rank reduction. Trickett does not teach a system that uses averaged signals, however Worley et al. specifically teaches that averaged NMR transients are used as an input to the system. It is inherent that the decimated data points have a smaller signal length and a sampling period greater than the input sampling frequency. It would have been obvious to one of ordinary skill in the art to combine these teachings, in order to reduce the amount of time involved in processing the data (Trickett, paragraph 17, lines 3-6).

12.   Regarding claim 11, with respect to claim 10, the further limitation,

... said vector space created by said noise-reduction pre-processor comprises an M-dimensional vector space defined by a number N_d - M + 1 of linearly independent M-dimensional vectors, and wherein said data processing system is configured to store said M-dimensional vectors in a form given by:

$c_n^d = (c_n^d, c_{n+1}^d, ..., c_{n+M-1}^d)$,

where c_n^d represent said decimated data points.

Worley et al. teaches a system that creates an M-dimensional vector space from NMR transients. It is inherent that the system stores the M-dimensional vectors. Trickett teaches the method of decimating the data. It would have been obvious to one of ordinary skill in the art to combine these teachings as stated previously, in order to store data more efficiently, which is a well-known goal in the art of digital storage.

13.   Regarding claim 12, with respect to claim 11, the further limitation

... said correlation matrix constructed by said matrix generator is Hermitian and covariant, and has a dimension MxM, and wherein said correlation matrix is formed from said M-dimensional vectors and in accordance with a formula given by:

$R_{ij} = 1 / (N_d - M + 1) \sum c_{n+i-1} c^{*}_{n+j-1}$

See Worley column 3, second paragraph. Worley teaches a system that uses an

autocorrelation function. It is well known in the art that in certain cases an

autocorrelation matrix is both Hermitian and covariant, specifically in the case of real

valued stationary random sequences with zero mean.

14.   Regarding claim 13, with respect to claim 11, see the preceding argument with

respect to claim 4

... said projection of said averaged signal by said signal projector is based on a projection formula given by:

$c_n^{nr} = \textstyle\sum_{k=1...K} (u^{*}_k, c_n) u_k$

where u_k represent said eigenvectors corresponding to said singular values.

Worley teaches a system analyzer that uses singular value decomposition techniques.

The system as taught by Worley, inherently includes a method of projecting a signal

onto eigenvectors.

15.   Claims 3, and 14-24 is rejected under 35 U.S.C. 103(a) as being unpatentable

over Worley and Keller as applied to claim 1 above and in further view of Broomhead et

al., and Okazaki (hereinafter Broomhead and Okazaki respectively).

16.   Regarding claim 3, with respect to claim 1, the further limitation, see Broomhead

... said control system comprises:

a. a graphics system adapted to generate a plot of said singular values, (fig. 4a and 5a)

b. a pattern recognition system adapted to identify a gap in said plot between said noisefree singular value and said adjacent noise singular value, and to verify the stability of said gap; and

c. a command signal generator, responsive to said pattern recognition system, configured to generate an output signal requesting for more measurements from said data acquisition system, in the absence of an definable gap, and to generate an output signal requesting that further measurements be discontinued, if the appearance and the stability of said gap has been established by said pattern recognition system.

Broomhead et al. teaches a processing system that performs singular value decomposition of time series signals from non-linear systems. The system does not perform pattern recognition, however the teachings point out the specific characteristics of the singular value plot (col. 12, lines 36-57). The system also does not request or discontinue further measurements. Keller teaches a system that request or discontinues further measurements. Okazaki teaches a pattern recognition system for identifying and retrieving two-dimensional information (col. 1, lines 18-31). Okazaki teaches that the system can be configured to recognize retrieval conditions (col. 2, lines 7-18). It would have been obvious to one of ordinary skill in the art to combine these teachings of Worley, Keller, Broomhead, and Okazaki for the purpose of creating a more user-friendly system. These systems when combined would shorten the length of time needed to acquire signals of interest.

17.   Regarding independent claims 14-19, 21, and 24, see the rejections of claims 1-5. The combination of Worley, Keller, Broomhead, and Okazaki teaches these features.

18.   Regarding claim 20, with respect to claim 19, the further limitation,

... said spectrum comprises an NMR spectrum, and said data measurements comprise NMR transient acquisitions.

Worley teaches a system that comprises an NMR spectrum and data measurements that comprise of NMR transient acquisitions (col. 1, first paragraph).

19.   Regarding claim 22, the further limitation of claim 21,

... steps b, c, and d are implemented by an operator of a control system.

Broomhead teaches a processing system that performs singular value decomposition of

time series signals from non-linear systems. They plot the singular values and point out

specific characteristics present in the singular plot (fig. 4a, item 80). It is inherent that

those specifics where chosen by the authors and furthermore it is inherent that an

operator can choose those characteristics in the same manner.

20.   Regarding claim 23, the further limitation of claim 21,

... steps b, c, and d are implemented by a processor upon execution by said processor of computer-usable instructions stored on a computer-usable medium.

Okazaki teaches a pattern recognition system to select user-defined characteristics of a

2-D plot, and Keller teaches a control system that responds to requests for additional

measurements.

Response to Arguments

21.   Applicant's arguments filed December 09, 2005 have been fully considered but

they are not persuasive.

22.   Regarding claim 1, see the preceding rejection under 35 USC 103. Keller

teaches a control system that specifies a termination criterion using a minimum signal-

to-noise criterion (Col. 9, lines 33-36). A SNR criterion is equivalent to identifying a gap

between a noisefree singular value and a noise singular value. There is a threshold

determined in Keller, which determines the difference between the signal and the noise,

or the noisefree signal and the noise signal. Worley teaches that the values considered

in the system are eigenvalues, so the combination thereof teaches that the eigenvalues

SNR determines the termination of measurement runs. This is equivalent to the

identification of a gap terminating the data acquisition.

Furthermore, applicant is directed towards a teaching by Laukien, U.S. Pat. No.

3,717,809. This reference reaffirms that SNR is relevant to the control subsystem. In

particular, Laukien teaches an apparatus which teaches that two different thresholds,

which are types of gaps, are used to conduct further scans and to stop them (Col. 1,

lines 43-55 and Col. 2, lines 7-44).

In response to applicant's arguments against the references individually, one

cannot show nonobviousness by attacking references individually where the rejections

are based on combinations of references. See *In re Keller*, 642 F.2d 413, 208

USPQ 871 (CCPA 1981); *In re Merck & Co.,* 800 F.2d 1091, 231 USPQ 375 (Fed. Cir.

1986).

Keller teaches the identity of a gap between signal (noisefree) and noise

components and Worley teaches the NMR data acquisition and analysis system.

23.   Regarding claims 2 and 4-8, see the preceding argument with respect to claim 1

and the current rejections under 35 USC 103.

24.   Regarding claims 9-13, see the current rejections under 35 USC 103. Trickett

teaches an eigen filtering techniques to reduce noise. In response to applicant's

argument that Trickett does not teach the limitations of claim 1, the test for obviousness

is not whether the features of a secondary reference may be bodily incorporated into the

structure of the primary reference; nor is it that the claimed invention must be expressly

suggested in any one or all of the references. Rather, the test is what the combined teachings of the references would have suggested to those of ordinary skill in the art. See *In re Keller*, 642 F.2d 413, 208 USPQ 871 (CCPA 1981). Trickett teaches mathematical concepts that are relevant to the teachings of Worley.

Trickett teaches that separating the signal in the frequency domain into constant-frequency slices, which is the equivalent to windowing, in order to reduce the bandwidth of the resulting signals. Further, Worley teaches inherent windowing is done in the system (Col. 1, para. 3). Worley teaches the autocorrelation matrix, wherein a different normalization parameter is used. It is inherent that different normalization parameters can be used to remove a bias, which is introduced by different assumptions about the statistics of the data gathered. Worley also teaches that a projection, or a dot product of two vectors, is performed to create the spectrum (Col. 3).

25.   Regarding claim 3, see the current rejections under 35 USC 103. Broomhead teaches a graphics system to plot the singular values. Singular values are synonymous to eigenvalues, and singular value decomposition (SVD) is the process of determining the eigenvalues and eigenvectors of a matrix. Broomhead teaches only the features lacking from the other references and does not need to teach the claimed invention as a whole.

26.   Ozaki teaches a system that can, in light of the prior teachings, identify a visual threshold, or a two-dimensional relationship, between the noise values and the noisefree values. The combination of Worley, Keller, Broomhead, and Ozaki teach the features of claim 3. In response to applicant's argument that there is no suggestion to

combine the references, the examiner recognizes that obviousness can only be

established by combining or modifying the teachings of the prior art to produce the

claimed invention where there is some teaching, suggestion, or motivation to do so

found either in the references themselves or in the knowledge generally available to one

of ordinary skill in the art. See *In re Fine*, 837 F.2d 1071, 5 USPQ2d 1596 (Fed. Cir.

1988)and *In re Jones*, 958 F.2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case,

the motivation is found in the knowledge generally available to one of ordinary skill in

the art.

27.   Regarding claims 14-19, 21, and 24, see the current rejections under 35 USC

103. The combination of Worley and Keller teaches elements a and b of claim 14,

element a of claim 15, element c of claim 16, elements b, c, d , and e of claim 17,

elements b, c, and d of claim 18, elements c, d, and e of claim 19, and elements a, b, c,

and d of claim 21, see the preceding argument with respect to claims 1, 2, 4, and 5.

The combination of Worley, Keller, Broomhead, and Ozaki teaches the elements f, g, h,

I, and j of claim 24.

28.   Regarding claims 20, 22, and 23, see the current rejections under 35 USC 103

and the preceding argument with respect to claims 19 and 21.

Conclusion

29.   The prior art made of record and not relied upon is considered pertinent to

applicant's disclosure. Hutson, U.S. Patent 5,490,516A, and IEEE Transactions on

Signal Processing "An Eigenanalysis Interference Canceler" by Haimovich et al.

(provided in the last action).

30.   Laukien, U.S. Pat. No. 3,717,809 – teaches a control subsystem, which

considers the SNR of the gathered measurements.

31.   **THIS ACTION IS MADE FINAL.** Applicant is reminded of the extension of time

policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE

MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not

mailed until after the end of the THREE-MONTH shortened statutory period, then the

shortened statutory period will expire on the date the advisory action is mailed, and any

extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of

the advisory action. In no event, however, will the statutory period for reply expire later

than SIX MONTHS from the mailing date of this final action.

Any inquiry concerning this communication or earlier communications from the

examiner should be directed to Daniel R. Sellers whose telephone number is 571-272-

7528. The examiner can normally be reached on Monday to Friday, 9am to 5:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's

supervisor, Sinh Tran can be reached on (571)272-7564. The fax phone number for the

organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the

Patent Application Information Retrieval (PAIR) system. Status information for

published applications may be obtained from either Private PAIR or Public PAIR.

Status information for unpublished applications is available through Private PAIR only.

For more information about the PAIR system, see http://pair-direct.uspto.gov. Should

you have questions on access to the Private PAIR system, contact the Electronic

Business Center (EBC) at 866-217-9197 (toll-free).

SINH TRAN
SUPERVISORY PATENT EXAMINER

DRS